

## Acquisition of food begging behavior by red foxes in the Shiretoko National Park, Hokkaido, Japan

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**Abstract.** In order to solve traffic problems and to understand possible epidemic risks resulting from the feeding of wild red foxes, *Vulpes vulpes*, the acquisition of food begging behavior by foxes in the Shiretoko National Park, Hokkaido, Japan was studied. Foxes were individually identified and their behavior was observed from June to October each year from 1992 to 1994. The locations of family territories and denning sites were established, and the degree of their tolerance to humans was investigated, and the relevancy of these factors in food begging behavior was examined. The development of food begging behavior among individuals less than one year old was strongly correlated ( $p < 0.01$ ) with their dens being within 20 m of the road edge. Most juveniles which were not born in dens near the roadside showed no food begging behavior and most individuals more than one year old, which had not previously shown such behavior did not acquire it at all, strongly suggesting that food begging behavior was predominantly acquired by juveniles denning near roads. Thus, preventing foxes from denning near roads should be an effective means to obstruct the acquisition of begging behavior.

**Key words:** food begging behavior, tolerance to humans, Shiretoko National Park, *Vulpes vulpes schrencki*.

Feeding wildlife is considered to be an undesirable recreation, which not only has considerable impact on wildlife (Nature Conservation Society of Japan 1978), but may also lead to risks for humans. Injuries to people have been caused for example by grizzly, *Ursus arctos*, and black bears, *U. americanus* (McCullough 1982, Robinson and Bolen 1989, Herrero and Fleck 1990, Wright 1992) in North America and by Japanese monkeys, *Macaca fuscata* (Wada 1989) in Japan, and Japanese monkeys have caused damage to crops as a result of feeding (Nature Conservation Society of Japan 1978, Wada 1989).

In the Shiretoko National Park (SNP), many red foxes, *Vulpes vulpes schrencki*, have been fed by park visitors since 1970 (Tsukada 1994, Watanabe and Tsukada 1996). The foxes have appeared on the road through the SNP during the daytime, some of them even lying down in the center of the road in order to stop vehicles and to obtain food from the drivers and passengers.

Some traffic accidents have occurred as a result of this behavior, when drivers have dodged foxes on the road. Traffic jams have also occurred in the SNP when vehicles have parked haphazardly to feed the foxes on the road during the peak visitor period of the summer vacation.

Some foxes in the SNP have become tame enough to be fed by hand by visitors who, by doing so, unwittingly run the risk of infection, because red foxes in Hokkaido are a definitive host of *Echinococcus multilocularis* which causes alveolar hydatid disease in humans (Yamashita 1978). Humans become infected accidentally by ingestion of the parasite's eggs deposited in fox feces (Yamashita 1978). Kondo *et al.* (1986) found that between 10% and 60% of the foxes in eastern Hokkaido were infected with this parasite. Coproantigen detection of fox feces (Nonaka *et al.* 1996) has confirmed the presence of echinococcus infection among some foxes inhabiting the SNP (Nonaka in prep.). When dogs are infected by *Echinococcus multilocularis*, various body surfaces, particularly of the anal area, the claws, femora and nose are typically contaminated with echinococcus eggs (Yamashita 1978), and this pattern is believed likely in infected foxes. As a consequence, direct physical contact with infected foxes begging for human food may, therefore, increase the risk of the transmission of this disease.

Although prohibiting park visitors from feeding wild foxes would help resolve these problems, there is no legal foundation for such a prohibition. In reality, it is very difficult to stop visitors to the SNP from tossing feeding foxes by hand, even where signs prohibiting the feeding of wild animals have been set up. Controlling the food begging behavior of red foxes is the obvious alternative, however previous studies have not attempted to clarify the conditions under which foxes come to be fed by people (Aoi *et al.* 1988).

In this paper, a study analyzing how foxes come to be fed by people is described, and means for controlling fox behavior are suggested.

## MATERIALS AND METHODS

### 1. Study area

The field study was carried out in the Shiretoko National Park (SNP) (44° 06'N, 145° 03'E) in the eastern part of the northern Japanese island of Hokkaido. Every year 1.5 million tourists visit the SNP. An intensive investigation was conducted along the approximately 20 km of main road which crosses the SNP. Half of the length of the road is paved and about 7.5 m wide, while the other half is narrow (5 m wide) and unpaved (Fig. 1). The whole road is closed throughout winter, from November to May, because of deep snow.

### 2. Observation of food begging behavior

The food begging behavior of foxes was defined as: 1) appearing on or alongside the road during the daytime when people might visit, and 2) staying in positions where drivers or passengers could notice them.

Forty-three foxes (18 males and 25 females) begging for food along the road

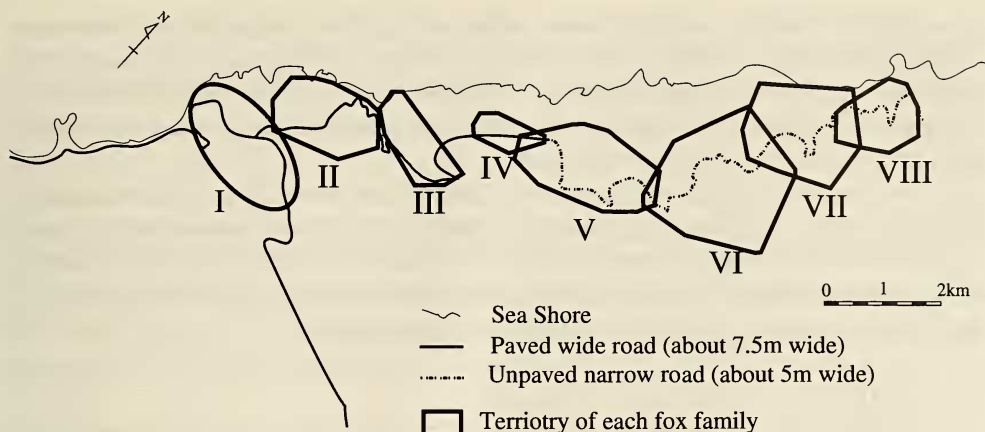


Fig. 1. Distribution of fox family territories in Shiretoko National Park. Territories II, IV, V, VI, VII and VIII are drawn on the basis of 95% Minimum Convex Polygons (MCP) of all locations of radio-collared females in reproductive condition from May to August 1993. Territory III is drawn by 95% MCP of all locations of a radio-collared male from May to August 1994. Territory I is roughly drawn from many sightings of its residents.

were captured either by using handmade blow darts, or padded foothold traps (Victor Soft Catch, Wood Stream Co.), and fitted with individually identifiable colored ear tags (Allflex 25, Allflex New Zealand Ltd.). Standard morphometrics such as body weight, body length and hind leg length were recorded. Individuals were assigned to one of three age classes (less than one year old, one year old, and more than one year old) which were determined by the annual attrition of incisors (Harris 1978). Because female foxes are capable of breeding at 10 months of age (Ables 1975), animals less than one year old were considered to be juveniles, and those one or more years old were adults. Whether pups were being reared by females was evaluated by the development of their nipples from May to July in 1992–1994.

Foxes which could not be captured but which were observed begging several times were identified by unique features such as pelage characteristics and scars, and by the location at which they appeared.

Observations of foxes begging were made from a car while driving along the main road through the SNP during the period from June to October in 1993 and 1994. Trips were conducted every two hours from 07:00 to 17:00 for two days each month, with additional trips made at random. Observations in 1992 were only conducted at random. The number of days of observation each month varied from seven to 21 (Table 2).

### 3. Identification of fox families

As in other areas, related adult foxes in the Shiretoko National Park usually shared common territories (Macdonald 1981, 1983, Murder 1985, Poulle *et al.* 1994, Tsukada 1997). Therefore, foxes appearing along the same sections of the SNP road were judged to share the same territories, while foxes

appearing at several widely dispersed locations were regarded as itinerants without territories. When there was at least one female in reproductive condition among members sharing a territory, the group was defined as a "reproductive family". The size of a reproductive family was counted in each territory during the years of the study.

Fox dens were searched for by tracking in the snow during the winters of 1992 and 1993. As some reproductive families built their dens near the road, signs of these den sites were searched for along the "roadside", that is within 20 m of each shoulder of the road during the period from May to August when the dens are usually occupied and used for pup-rearing.

#### 4. The Degree of tolerance to humans

To evaluate the degree of tolerance to humans, each fox was approached and the distance at which the fox began to flee was recorded (Table 1). The investigation was conducted more than once for each animal between June and October 1994. Mean scores were calculated for each animal and used as an index of the degree of their tolerance towards humans.

Table 1. The scores and criteria of degrees of tolerance to humans in foxes.

Scores	Criteria
	Fox begins to flee ;
1	when a vehicle approaches
2	when the researcher alights from the vehicle at $\geq 5$ m
3	when the researcher approaches to a distance $\geq 5$ m
4	when the researcher approaches to a distance $\geq 3$ and $< 5$ m
5	when the researcher approaches to a distance $\geq 1$ and $< 3$ m
6	when the researcher approaches to a distance $\leq 1$ m or does not flee

## RESULTS

Fifty foxes were observed begging for food from people during the study period. Twenty-eight of these (12 males and 16 females) were adults, six (2 males and 4 females) were juveniles at first but later became adults and 22 (sex unknown) were juveniles. Eight territories were confirmed by radio-tracking (Table 2), four territories (I-IV) were located along the wide paved section of the SNP road, while the other four (V-VIII) were located along the narrow unpaved section (Fig. 1). The locations and sizes of these territories were essentially stable during the years 1992-1994.

The number of adult foxes observed begging, and the time they spent begging each year varied among the various territories. In territories I, II and III, the maximum number of adults observed begging was two, whereas in territory VI it was three, and in IV, V, VII and VIII, it was four. The maximum number of adults begging in each territory and in each year was significantly higher in territories along the narrow unpaved section of the SNP





Table 3. Correlationship of begging human food by juvenile foxes with the shift of their dens toward the roadside (20 m or less from road shoulders). Begging food by one or more juveniles in each reproductive family is indicated as "+". Den shift toward the roadside of the main road in the national park is indicated as "+", and the earliest date of confirmation for the den shift is shown in parentheses.

	Reproductive family							
	I		II		III		IV	
	Begging	Roadside den	Begging	Roadside den	Begging	Roadside den	Begging	Roadside den
1992	-	-	no reproduction		-	+ (6 Aug)	-	-
1993	+	+ (17 July)	-	-	-	-	+	+ (20 July)
1994	+	+ (22 June)	-	-	-	-	+	+ (12 July)
	V		VI		VII		VIII	
	Begging	Roadside den	Begging	Roadside den	Begging	Roadside den	Begging	Roadside den
1992	+	+ (29 May)	-	-	+	+ (3 July)	-	-
1993	+	+ (9 June)	+	+ (24 June)	+	+ (23 June)	-	-
1994	+	-	-	-	+	+ (29 June)	-	-

that is, 10 out of these 11 families moved their dens to the roadside during June and July (Table 3). Conversely, 11 out of the 12 reproductive families which did not move their dens to the roadside also had no juvenile which begged (Table 3). Therefore, whether a juvenile showed food begging behavior or not was significantly correlated with whether its family moved their den to the roadside or not (Fisher's exact probability test,  $p < 0.01$ ). However, the number of families wherein at least one juvenile begged did not differ significantly between the territories along the wide paved road and those along the narrow unpaved section (Fisher's exact probably test,  $p > 0.05$ ).

The degree of tolerance towards humans was measured among 21 adult foxes. The mean score, 3.66 (range: 1.4-5.9,  $SE$ : 1.20) did not differ between age classes, sexes or the reproductive conditions of females ( $U$ -test,  $p > 0.05$ ; Tables 2 and 4). The foxes in the territories along the narrow unpaved section of the SNP road, however, showed a significantly higher degree of tolerance to humans than those in the territories along the wide paved section ( $p < 0.01$ ). The most highly tolerant foxes lay down in the center of the road in order to

Table 4. The degree of tolerance to humans among adult foxes which showed food begging behavior in 1994 comparing age, sex, reproductive condition of females and the road-type in territories.

Fox categories	$n$	Mean	$SE$	$U$ -test
One year old	5	4.62	0.37	
More than 1 year old	16	3.36	0.29	$p > 0.05$
Adult male	6	3.35	0.34	
Adult female	15	3.78	0.35	$p > 0.05$
Female in reproductive condition	10	3.47	0.42	
Female in non-reproductive condition	5	4.41	0.56	$p > 0.05$
Wide paved road	7	2.54	0.38	
Narrow unpaved road	14	4.22	0.23	$p < 0.01$

stop vehicles and were willing to be fed by hand.

Only two adults began begging halfway through the study period. One of these was the male "Ka" in territory VIII, which first began begging for food in May 1993. Even on first contact, "Ka" did not flee, moreover, he approached the survey vehicle even though he had not previously taken food from visitors there. "Ka" was thereafter observed frequently even at night, and showed a high degree of tolerance with a score of 4.5. The other was the adult female "Th", which first began begging in April 1993. Her behavior was unique in that she began by fleeing as a vehicle approached, but then stayed within sight of the driver and waited to be fed. "Th" was less tolerant of humans in 1993 and this tendency did not change in 1994. Her degree of tolerance towards humans was the lowest scored (1.4) during this study.

## DISCUSSION

There was a strong correlation between the acquisition of begging behavior among juveniles and denning near the road. This correlation could be accounted for partly by the fact that juveniles usually confine their activities to the area around their den until July, after which they are taken on exploratory trips by adults (Henry 1986, personal observations). None of the juveniles denning away from the roadside, however, began begging even when they were able to move around the whole of their parent's range during September and October (personal observations). This strongly supports the belief that denning near the road is an important contributory factor in the acquisition of begging behavior among juveniles. The numerous opportunities for interacting with people along the road near their den, and for contact with adults already showing begging behavior might facilitate the learning of the same habit among juveniles.

Some adults were not observed begging at any time during the study period, even though other individuals living in the same territories were. Furthermore, only two adults commenced begging during the study period. However, one of the two, the adult male "Ka" was considered to have already acquired the begging habit somewhere else before settling in territory VIII in spring 1993, because he was observed begging when he could not have had any opportunities to learn the behavior in the territory. The other individual "Th" began begging in April 1993, but differed from other foxes in that she was extremely intolerant of people. It appears, therefore, that acquiring the begging habit is difficult for adult foxes.

The degree of tolerance to humans and the duration of begging among adults differed among territories. Seasonal variation in begging behavior among red foxes in the SNP depends on the availability of its major natural food items (Tsukada and Nonaka 1996). It is assumed, therefore, that the differences in begging behavior observed among adults were related to the availability of natural foods in each territory. Indeed, each territory was located in a slightly different habitat, which would lead to differences in the

available food items among neighboring territories (Macdonald 1981).

Adults in the territories along the narrow unpaved section of the SNP road showed a high degree of tolerance to people. Two possible reasons for this should be considered. Firstly, that highly tolerant foxes choose territories along this section of the road, or join a family with such a territory. Secondly, that environmental conditions along this section of the road encourage foxes to be more tolerant.

A fox family is usually composed of a matrilineal kinship group (Macdonald 1983). Hence, migration of adult females between families does not occur. In fact, only adult males migrated into certain family territories in the study area (unpubl. data). Furthermore, the locations of the territories changed little over three years (Tsukada 1997), and had probably not changed over a longer period (Watanabe and Tsukada 1996). Therefore, the first possible reason is unacceptable. On the narrow unpaved section of the road, the view is blocked by numerous roadside trees and blind corners. Under these conditions begging foxes must endure the closer approach of vehicles and people here than on the wider paved section. Furthermore, the narrow shoulders of the unpaved section prevents foxes from taking food from visitors at a distance. Hence, foxes in territories along this section would become more tolerant than those in territories along the wider paved section. A similar effect of road structure where they usually forage on tolerance to people has also been observed among Japanese macaques (Sugiura *et al.* 1993).

In conclusion, begging is a behavior readily acquired by juvenile foxes denning near roads, but is not typically acquired by adults. Environmental factors, such as road type did not affect acquisition of begging behavior, but the degree of tolerance to people among adults did. Therefore, the most effective means of controlling begging by red foxes would appear to be to prevent them from denning near roads. This would eliminate the possibility of juvenile foxes developing the begging habit and result in diffusion of the behavior over generations. It might thus be possible to eliminate begging entirely from the study area. Because physical and human disturbance makes foxes shift their dens (Lloyd 1980, Stubbe 1980, Sargeant *et al.* 1984, Henry 1986), the selective destruction of dens near roads, and threats made to foxes denning near road by humans or dogs may both be effective means of dispersing problematic foxes. If a direct and intensive control program of foxes in the SNP is necessary, then aversive conditioning should be introduced to a limited part of their range, namely the area along the narrow unpaved road, since that is where potentially infectious (because of their likelihood of having direct physical contact with humans) foxes live.

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